RADIAL-PLY TIRE

REFERENCE TO RELATED APPLICATIONS

This is a continuation of application Serial No. 08/890,730, filed July 11, 1997, pending, which is a continuation of application Serial No. 08/610,795, filed March 11, 1996, now abandoned, which is a continuation of Serial No. 08/355,411, filed December 9, 1994, now abandoned, which is a continuation of application Serial No. 08/140,698, filed October 21, 1993, now abandoned, which is a continuation of application Serial No. 07/918,163, filed July 21, 1992, now abandoned, which is a continuation of application Serial No. 07/503,391, filed April 2, 1990, now abandoned.

BACKGROUND OF THE INVENTION

Technical Field

The present invention relates to a radial-ply tire having a belt consisting of 4 or more plies and disposed on a carcass with interposed rubber pads, and more particularly to a radial-ply tire improved in camber thrust characteristic.

Background Art

Fig. 3 is a schematic partial section view showing a conventional radial-ply truck/bus tire which is generally used at an inflation pressure not less than 4 kg/cm2.

The circumferential surface of a carcass 10 is braced by a belt 20. This belt 20 consists of four plies 21, 22, 23 and 24. These belt plies may for example be rubber-topped steel cords, with rubber pad 30 being interposed between the ends of these plies and the carcass 10. Of the four plies, the second ply 22 has the maximum width MBW, with the third and fourth plies 23, 24 having progressively diminishing widths. Furthermore, tread rubber 40 is laid on the belt 20. The width of this tread rubber 40, which means the tread width TW, is larger than the maximum belt width MBW.

In the conventional radial-ply tire described above, in which the widths of all the belt plies 21, 22, 23, 24 are smaller than the tread width TW, the tread stiffness shows a sudden decrease at the side edges of the tread rubber 40 so that when the tire has been caught in a rut, a negative camber thrust is generated, provided that the camber in the upward direction along the slope of the rut is taken as being the positive camber. Therefore, the problem arises that unless the steering wheel is turned much, the

vehicle cannot be successfully dislodged from the rut.

With the foregoing in view, it is an object of the present invention to achieve a positive camber thrust with a radial-ply tire having a belt of 4 or more plies on a carcass with interposed rubber pads.

SUMMARY OF THE INVENTION

The radial-ply tire of the present invention has a belt consisting of 4 or more plies between a carcass and a tread, the respective ends of the plies being kept isolated from the carcass by respective rubber pads interposed therebetween, the width TBW of the outermost belt ply being larger than the width NBW of the adjacent ply and the value of K given by the following equation being not less than 0.1 and not more than 0.4.

$$K = \frac{MBW-TW}{OW-TW}$$

where MBW is the maximum belt ply width, OW is the maximum tire width and TW is the tread width.

In this radial-ply tire, the tread portions disposed externally of the conventional belt region, that is to say, the side edges of the tread, have an increased stiffness to generate a positive camber thrust. Therefore, with this radial-ply tire, the vehicle can be easily dislodged from a rut with a large slope without turning the steering wheel through a

large angle. If the value of K is less than 0.1, inclusive of the negative range, the value of camber thrust will be negative. If the value of K exceeds 0.4, difficulties will be encountered in the manufacture of the tire.

Furthermore, as the outermost belt ply width TBW is increased over the tread width TW, the ends of this outermost belt ply are disposed closer to side walls of tire shoulders so that not only the strain of the belt ends due to loading is decreased but also irregular wear of the tread ends is suppressed to thereby contribute to an increased tire durability.

Furthermore, as the side wall of the tire shoulder is elevated at an imaginary extension of the belt, the ends of all the belt plies adjoin a comparatively thick body of rubber so that the concentration of stresses at the ply ends is relieved by deformation of the rubber.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1a is a schematic partial section view showing a radial-ply tire according to one embodiment of the invention;

Fig. 1b is an enlargement of a portion of Fig. 1a showing a sidewall configuration;

Fig. 2 is a diagrammatic representation of the camber thrust generated in the radial-ply tire of the same embodiment versus the camber thrust generated in the conventional radial-ply tire; and

Fig. 3 is a schematic partial section view showing a conventional radial-ply tire.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 1a is a schematic partial section view showing the radial-ply tire according to one preferred embodiment of the invention. Like the tire described hereinbefore, this is also a tire for trucks and buses which is used at an inflation pressure not less than 4 kg/cm2.

In this embodiment, too, a belt 20 bracing the circumferential surface of a carcass 10 consists of 4 plies 21, 22, 23, 24. These belt plies may for example be rubber-topped steel cords and rubber pad 30 is interposed between the ends of these plies and the carcass 10. Instead of steel cords, aromatic polyamide (aramid) cords, each of which has relatively high Young's modulus, may be employed. Of these 4 plies, the second ply 22 has the largest width MBW and the width TBW of the fourth ply 24 is larger than the width NBW of the third ply 23. Furthermore, tread rubber 40 is laid on the belt 20. However, unlike the conventional tire construction, the width of this tread rubber 40, that is to say the tread width TW, is smaller than the width of the second ply 22, i.e. the maximum width MBW of the belt, and also smaller than the width of the fourth ply 24, i.e. the outermost belt ply width TBW.

Furthermore, the value of K given by the equation

$$K = \frac{MBW - TW}{OW - TW}$$

where OW is the maximum width of the tire is not less
than 0.1 and not more than 0.4. It should be under-
stood that all the dimensions, such as MBW, represent
linear distances as illustrated. Furthermore, in this
embodiment, near an imaginary extension E of the belt
20 and on the side wall of the shoulder portion, an
elevation 50 having a height H of 3 to 20 mm is
provided as shown in Fig. 1b.

In the radial-ply tire according to the above
embodiment, the ends of all the plies 21, 22, 23, 24
are kept isolated from the carcass 10 by the interposed
rubber pad 30 so as to prevent concentration of
stresses at the ends of the plies. Furthermore, as the
width TBW of the fourth ply 24 is increased over the
tread width TW to thereby provide a distance between
the end of this ply and the tread end, the end of the
fourth ply 24 is hardly subject to the influence of the
stress generated on contact of the tread with the
ground surface so that the strain of the belt end under
loading is minimized. Moreover, as the ends of this
fourth ply 24 are disposed closer to the shoulder side
walls than they are in the conventional tire, the
dissipation of heat is encouraged. Generally speaking,
the end of the ply reinforced by a bias cord is weak in

self-bracing power because the ply is terminated there.
In addition, the fourth ply 24 which is located outer-
most is not supported by other plies. Therefore, the
end of the fourth ply 24 tends to be relatively mobile.
However, in the radial-ply tire of this embodiment, it
is not the mobile end of the fourth ply 24 but the
inner less-mobile portion thereof that is located below
the tread end, with the result that the tread end is
less movable and hence irregular wear is suppressed.
Furthermore, since the surface of the side wall of the
tire shoulder is raised near the imaginary extension E
of the belt 20 as indicated by the reference numeral
50, the ends of the second and fourth plies 22, 24
adjoin a comparatively thick body of rubber so that the
stress concentration at the ends of these plies 22, 24
is relieved. The height of the elevation 50 is 3 to 20
mm and preferably 3 to 15 mm. If the height of eleva-
tion 50 is less than 3 mm, its dispersing effect on
stress concentration at the ply ends will not be
sufficient. If the height is increased beyond 20 mm,
the intention to prevent temperature buildup by dis-
posing the ply ends closer to the side wall of the
shoulder will not be fully realized. The optimum
height depends on the heat-generating potential of the
rubber constituting this elevation 50. Moreover, the
tread stiffness of the tread rubber 40 is equalized to
yield a positive camber thrust as explained below.

Fig. 2 is a diagrammatic representation of the relationship of the K values of radial-ply tires having various steel cord belt widths with the values of camber thrust CT generated in the respective tires. It should be understood that the camber thrust CT values were measured with the camber angle being set at 8 degrees for 11R22.5 14PR tubeless tires.

As apparent from the same view, while the CT value is negative when K is negative, a positive camber thrust CT value is obtained when K is not less than 0.1 and not more than 0.4. Therefore, when the radial-ply tire of the invention is employed, the vehicle can be easily dislodged from a rut with a large angle of Inclination without turning the steering wheel through a large angle.

It should be understood that the invention is not only applicable to the 4-ply construction described hereinbefore but also applicable generally to radial-ply tires having more than 4 plies on the carcass with interposed rubber pads and that the invention is also applicable to tires for light-duty trucks in addition to the above-described tires for trucks and buses.